

REMARKS

Claims 1 and 3-7, following entry of this Amendment, are all the claims pending in the present application. Claim 2 has been canceled. Claims 4-7 have been withdrawn from reconsideration.

Reconsideration of the subject patent application and allowance of all of the claims is respectfully requested in view of the foregoing amendments and the following remarks.

Claim 1 has been rejected under 35 U.S.C. § 102(b) as being anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as being unpatentable over El-Kareh et al. (U.S. Patent No. 4,725,562) (hereinafter "El-Kareh"). This rejection, as it may apply to amended claim 1, is respectfully traversed.

Applicable case law holds that in order to anticipate a claim, a single prior art reference must disclose each and every feature of the claim. Furthermore, in order for prior art to render a claim obvious, the prior art must suggest all of the claimed features and their combination to a person of ordinary skill in the art. In the present case, El-Kareh does not teach or suggest each and every feature of the claimed invention.

↑
shown
in Ref. Independent claim 1 now recites a high voltage semiconductor device, comprising a high concentration collector area of a first conductive type, a low concentration collector area of a first conductive type formed on the high concentration collector area, a base area of a second conductive type formed on the low concentration collector area and having a trench which penetrates the low concentration collector area in a vertical direction at a junction termination, a high concentration emitter area of a first conductive type formed on a predetermined upper surface of the base area, and an emitter electrode, a base electrode, and a collector electrode isolated from one another and connected to the emitter area, the base area, and the collector area, respectively, wherein the depth of the trench is 50-150 μm . amend'd
"Junction termination area"

↓
does El-Kareh does not disclose a base area having a "trench which penetrates the low concentration collector area in a vertical direction at a junction termination," "wherein the depth of the trench is 50-150 μm ," as set forth in claim 1. The trench of El-Kareh is applied to a

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Application, *fw*

general IC structure, and is positioned in an active cell. Further, the trench penetrates the p base region and n+ emitter region, and the depth of the trench is several μm . Clearly, this is adverse ? *how* to the teachings of the present invention.

In contrast, the trench of claim 1 is applied to a high voltage power discrete device, and is positioned at a "junction termination." The trench only penetrates the p base region, and has a depth of "50-150 μm ." Since El-Kareh does not teach or suggest each limitation of claim 1, El-Kareh cannot anticipate this claim. Moreover, El-Karen does not render claim 1 obvious. Thus, the rejection of claim 1 should be withdrawn. *to collection*

Dependent claim 2 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over El-Kareh in view of Chittipeddi et al. (U.S. Patent No. 6,358,785) (hereinafter "Chittipeddi").¹ The combined disclosures of El-Kareh and Chittipeddi do not render claim 2 obvious because there is no motivation, absent the hindsight reconstruction of the present invention, to modify the disclosure of El-Kareh in accordance with the disclosure of Chittipeddi.

"When a rejection depends on a combination of prior art references, there must be some teaching, suggestion, or motivation to combine the references." In re Rouffet, 47 USPQ2d 1453, 1456 (Fed. Cir. 1998); see also MPEP § 2143.01. Virtually all inventions are combinations of old elements. See In re Rouffet, 47 USPQ2d at 1457. If identification of each claimed element in the prior art were sufficient to negate patentability, the Patent Office could use the claimed invention itself as a blueprint for piecing together elements in the prior art to defeat the patentability of the claimed invention. See id. To prevent the use of hindsight based on the teachings of the patent application, the Patent Office must show a motivation to combine the references in the manner suggested. See id. at 1457-58.

In Rouffet, the Court of Appeals held that although all elements recited in the claims of Rouffet's application were disclosed in the applied prior art references, the rejection under 35 U.S.C. § 103 was improper because there was no suggestion as to why one skilled in the art

¹ Claim 2 has been canceled, and thus, the rejection of claim 2 is rendered moot.

would have been motivated to combine the references in such a manner as to render the claims obvious. See id. at 1457.

The situation is, at best, the same in this case. Even if all elements recited in the pending claims can be found in the combined disclosures of El-Kareh and Chittipeddi, there is no reason that one of ordinary skill in the art would have been motivated to combine these references in such a manner as to render the pending claims obvious. It is suggested in the Office Action that it would have been obvious to a person of ordinary skill “to modify the trench structure of El-Kareh et al. with the teaching of Chittipeddi et al. since such a shallow trench conforms to the current effort of minimizing a size of an IC device.” The current effort of the present invention is to reduce the concentration of an electric field at a cylindrical junction or, in the alternative, prevent a strong electric field from being generated at the end of a high voltage device. Minimizing the size of an IC device is merely incidental. Further, the Patent Office’s rationale is not suggested anywhere in the applied references; it is no more than a hindsight reliance on the teachings in the present application.

As equipment becomes larger in size and capacity, high voltage semiconductor devices having a high breakdown voltage, a high current and a fast switching speed become more important. In order to decrease power loss in a conductive state even while a large amount of current is flowing, the saturation voltage of high voltage semiconductor devices is required to be low. High voltage semiconductor devices are fundamentally required to have a characteristic of resisting a reverse high voltage applied to both ends thereof in an off-state or at the moment the device is turned off. That is, high voltage semiconductor devices are fundamentally required to have a high breakdown voltage. A variety of breakdown voltages of power semiconductor devices are required to be in a range from several tens of volts to several thousands of volts.

Generally, the breakdown voltage of a semiconductor device largely depends on a depletion region extending from a PN junction, and particularly, is greatly influenced by the curvature of the depletion region. In particular, for a planar junction, an electric field is concentrated on the edges, which have a large curvature, thereby decreasing the overall

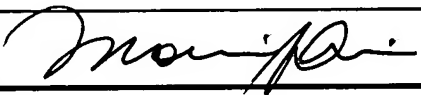
breakdown voltage. Accordingly, a number of methods have been proposed in order to obtain high breakdown voltage by preventing an electric field from being concentrated on the edge of a junction.

The present invention accomplishes the above by utilizing a high voltage semiconductor device having a trench with a width that is $1/10$ times the depth of the trench. The shape of the depletion area varies depending on the width of the trench, and the breakdown voltage property varies depending on the shape of the depletion area.

El-Kareh fails to teach or suggest the base area having a trench that penetrates the low concentration collector area in a vertical direction at a junction termination, wherein the trench width is $1/10$ times the depth, as discussed above. Chittipeddi concerns a method of forming shallow trench isolation structures "to avoid adjacent devices from shorting to one another" and "to avoid leakage between devices formed in close proximity to one another." Column 1, lines 15-18. Chittipeddi discloses a trench opening with a trench width of 0.1 microns to 2.0 microns and a trench depth no greater than 1 micron. However, there is no teaching or suggestion, absent the hindsight reconstruction of the present invention, as to why one skilled in the art would have been motivated to combine the El-Kareh and Chittipeddi references. Thus, neither the individual or combination of the El-Kareh and Chittipeddi references discloses the present invention.

Dependent claim 3 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over El-Kareh. Claim 3 depends on independent claim 1, and is submitted to be patentable for at least the same reasons discussed above with respect to claim 1.

Applicant submits that the present application is now in condition for allowance.
Reconsideration and favorable action are earnestly requested.

RESPECTFULLY SUBMITTED,					
NAME AND REG. NUMBER	Monica S. Davis, Registration No. 44,492				
SIGNATURE				DATE	March 4, 2003
Address	Rothwell, Figg, Ernst & Manbeck 1425 K Street, N.W., Suite 800				
City	Washington	State	D.C.	Zip Code	20005
Country	U.S.A.	Telephone	202-783-6040	Fax	202-783-6031

Attachment: Marked-Up Copy of Amendments

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Amended Claim - Changes made

1. (Amended) A high voltage semiconductor device, comprising:
 - a high concentration collector area of a first conductive type;
 - a low concentration collector area of a first conductive type formed on the high concentration collector area;
 - a base area of a second conductive type formed on the low concentration collector area and having a trench which penetrates the low concentration collector area in a vertical direction at [the edge of the trench] a junction termination;
 - a high concentration emitter area of a first conductive type formed on a predetermined upper surface of the base area; and
 - an emitter electrode, a base electrode, and a collector electrode isolated from one another and connected to the emitter area, the base area, and the collector area, respectively,wherein the depth of the trench is 50-150 μm .